Geologic Resources Inventory Workshop Summary
Craters of the Moon National Monument, Utah
May 12-13, 1999

National Park Service
Geologic Resources Division
and
Natural Resources Information Division

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EXECUTIVE SUMMARY

An inventory workshop was held at Craters of the Moon National Monument on May 12-13, 1999 to view and discuss the park's geologic resources, to address the status of geologic mapping for compiling both paper and digital maps, and to assess resource management issues and needs. Cooperators from the NPS Geologic Resources Division (GRD), Natural Resources Information Division (NRID), Columbia Cascades Support Office (CCSO), Craters of the Moon NM (interpretation, resource management and superintendent), US Geological Survey (USGS), and local academic researchers were present for the two-day workshop. (***see Appendix A, Craters of the Moon NM Geological Resources Inventory Workshop Participants, May 12-13, 1999***)

Day one involved a field trip led by USGS Geologist Mel Kuntz, who has done extensive geologic mapping and research in Craters of the Moon NM

An on-line slide show of the highlights of the field trip can be found at http://www.nature.nps.gov/grd/geology/gri/id/crmo/field_trip_crmo

Day two involved a scoping session to present overviews of the NPS Inventory and Monitoring (I&M) program, the Geologic Resources Division, and the ongoing Geologic Resources Inventory (GRI). Round table discussions involving geologic issues for Craters of the Moon NM included interpretation, paleontological and cave and karst resources, the status of cooperative geologic mapping efforts, sources of available natural resource data, geologic hazards and other management issues, unique geologic features, potential future research topics, and action items generated from this meeting. Brief summaries of each follows.

Craters of the Moon NM GRI Workshop Summary:
May 12-13, 1999 (cont'd)

OVERVIEW OF GEOLOGIC RESOURCES INVENTORY
After introductions by the participants, Joe Gregson (NPS-NRID) presented an overview of the NPS I&M Program, the status of the natural resource inventories, and the geological resources inventory (***see Appendix B, Overview of Geologic Resources Inventory***).

He also presented a demonstration of some of the main features of the **digital geologic map** for the Black Canyon of the Gunnison NM and Curecanti NRA areas in Colorado. This has become the prototype for the NPS digital geologic map model as it ideally reproduces all aspects of a paper map (i.e. it incorporates the map notes, cross sections, legend etc.) with the added benefit of being a GIS component. It is displayed in ESRI ArcView shape files and features a built-in help file system to identify the map units. It can also display scanned JPG or GIF images of the geologic cross sections supplied with the map. The cross section lines (ex. A-A') are subsequently digitized as a shape file and are hyperlinked to the scanned images.

For a recap on this process, go to:
http://www.nature.nps.gov/grd/geology/gri/blca_cure/ ***and view the various files in the directory.***

The geologists at the workshop familiar with GIS methods were quite impressed with this method of displaying geologic maps digitally; Gregson is to be commended for his accomplishments.

Tim Connors (NPS-GRD) followed with an introduction to the Geologic Resources Division. See the website for more information at: http://www2.nature.nps.gov/grd/

INTERPRETATION
The GRI aims to help promote geologic resource interpretation within the parks and GRD has staff and technology to assist in preparation of useful materials including developing site bulletins and resource management proposal (RMP) statements appropriate to promoting geology. Jim Wood (GRD) and Melanie Moreno (USGS-Menlo Park, CA) have worked with several other NPS units in developing web-based geology interpretation themes, and should be considered as a source of assistance should the park desire.

One of the major topics of discussion centered around the development of a publication summarizing the geology of Craters of the Moon to be available to visitors. Mel Kuntz has wanted to produce such a publication for the monument; in fact his co-authors on several projects (Dick Lefever and Duane Champion) worked on a first draft of "Geology of Craters of the Moon", but it was never published.

Mel's time is booked on other USGS assignments so any work he could put in to this project would be solely in his personal free time. He mentioned that if his salary could

be funded to work on the project for six months, he could have a product in seven months, but the likelihood of his time being dedicated to this is slim-to-none. He mentioned that he would like to work with Dave Clark (CRMO) jointly on this in their retirements, but that is still a few years away also.

Dave Clark and John Apel would like to see the CRMO Natural History Association become involved in the production of this publication too, but they do not have the funds or staff to cover this endeavor by themselves. It was suggested to pursue other avenues (Universities, the Department of Energy, etc.) for help in achieving publication. A professional publication is likely to cost in excess of $30,000 for a color book and should also be available in a digital PDF format for easy web downloading. It would be most desirable to have a publication that would cost less than $10.00 for the consumer. The GRI may be able to also assist in funding this endeavor.

Jim Morris would like to have such a publication emphasize the Great Rift and it was thought that the BLM, DOE and South-Central Idaho tourism groups might buy into such a project. Other possible partners could be the folks who initially sponsored Mel's mapping and other work at CRMO.

It was suggested to develop a sample outline and subsequent chapters to demonstrate to potential funding sources to gauge their interest in participating in such a project.

CRMO has had Michelle Mycross (a geology graduate student from Western Washington) work with them in the past and it was thought that she may be returning soon. She might make a good candidate to work on the project also.

PALEONTOLOGICAL AND SPELEOLOGICAL RESOURCES

Natural Resources pertaining to paleontology and caves were briefly discussed and the following items were pointed out:

- There are tree molds in the Blue Dragon Flow dated at ~2100, & 6500 year events on the West Side of Silent cone.
- Trace fossils exist within the monument boundaries.
- Holocene animal bones are present in some of the lava tubes. There is apparently a collection at the park. Vince Santucci (NPS-GRD Paleontologist) would be most interested in these.

STATUS OF GEOLOGIC MAPPING EFFORTS FOR CRATERS OF THE MOON NM

For the most part, the geologic map of Craters of the Moon by Mel Kuntz (USGS) is complete in both paper (Open File Report 94-659) and digital format. It is mapped at *1:100,000* scale. Digitizing was accomplished through joint efforts of the Columbia Cascades Support Office and the IM program of the NPS. The IM program contributed $10,000 to fund digitizing of Mel's maps.

Joe Gregson (NPS-NRID) presented a demonstration of the ESRI ArcView map to the workshop participants. It features a windows-based help file much like the Black Canyon NM map that he also presented, and is quite impressive.

A few minor additions are desired to complete the digital geologic coverage of the monument area. Mel estimates that it will take him approximately half a day in an office with a stereo plotter to finish the desired portions, and should not require any field checking. He could have a product within 1-2 days of starting. It was suggested that the NPS request Mel's time to complete the mapping and it was agreed that the NPS will send a letter to his superiors with such a request.

The subject of protecting cave resource locations on geologic maps was discussed in depth. According to the Federal Resources Cave and Karst Protection Act, certain locations are not to be in the public domain. One such example is **Surprise Cave**, which does appear on Mel's map. It will need to be removed by NRID. The protocol for determining which locations will appear on maps is as follows:
if it is shown on the park map that is distributed to the visiting public, it is satisfactory to reveal the location on other maps. If it doesn't appear on the park map, then it is to be held as not available to the public and is not to be placed on any other literature and maps.

NPS Cave Specialist Ron Kerbo is working with the USGS to have secret cave locations removed from existing topographic map coverages to protect locality information, as they are also exempt from FOIA requests.

OTHER SOURCES OF NATURAL RESOURCES DATA FOR CRATERS OF THE MOON

- NRID has compiled a geologic bibliography for numerous parks and monuments, including Craters of the Moon. Visit the website at: http://165.83.36.151/biblios/geobib.nsf; user id is "geobib read", password is "anybody".
- Mel has a Geological Society of America (GSA) Memoir 179 (1986) that has a good abstract summarizing the geology of CRMO that would be good material for a website; permission needs to be sought from GSA to reprint and possibly web post
- There is a 1989 American Geophysical Union (AGU) guide; but I'm not sure of the title or author. Does anyone else know what it was ?
- Mel's Open File report map and NRIDs digitized version of the same
- Bill Lehman has worked on Precambrian granulite xenoliths; report should be sought out
- Snake River Plain database on basalt rocks by Idaho State University (mentioned by Scott Hughes); has 300-400 trace element analyses from Snake River Plain area
- CRMO is part of the DOE Seismic network as 1 of 27 stations; Suzette Payne is the contact
- Air Quality Data (it is in a class 1 area); consult NPS-ARD AQUIMS database to see what data they may have. Apparently John Apel has just received copy of AQUIMS from ARD.

- Doug Owen thought that a major shortcoming of the NRID demonstration of the CRMO map was the inability to show inventories of specific features. NRID needs to find a way to display this data once it is fully inventoried.

Disturbed Lands

- Martin Mine (GRDs Dave Steensen helped on reclamation project); still needs some reclamation work as some heavy metal contamination may be reaching streams; needs assessed by WRD; abandoned roads lead to the mine also
- Cinder/borrow pits within the monument
- abandoned roads: park entrance road coming into boneyard (storage area) and to the borrow pit
- abandoned dump from possibly the 1930s at the north end of the park
- Old sheep road; partially reclaimed near Broken Top. It's a trail now so probably truly isn't disturbed
- Old snowmobile track is expressed as vegetation distribution difference because of compaction
- Top of Inferno Cone where foot traffic erosion is extensive; existing exhibits on the top of the cone will be removed and new ones emplaced at the base of the cone to minimize foot traffic on the cone
- All asphalt trails shedding gravel onto the native bedrock

GEOLOGIC HAZARDS AND OTHER RESOURCE ISSUES

There are numerous issues related to geologic hazards in and around Craters of the Moon NM. Below is a brief list of some mentioned during the scoping session:

- The potential for a volcanic eruption is a very real possibility
- Sharp rocks; basalts along trails or quite abrasive
- avalanche hazards
- Regional earthquake hazards (i.e. Borah Peak 7.3 Magnitude of 1983)
- Dangerous cave entrances related to collapsing lava tubes
- Rockfalls accelerated by freeze-thaw cycles
- Shoulders of roads are being undercut from snowmelt run-off
- Public use impacts from pedestrian erosion
- Cave identification for lava tubes/public access to lava tubes and subsequent results on biological resources
- Ron would like any inventory of the cave resources for impacts that might result
- Cave sanitation issues (defecation/urination in caves)
- Confined space standards for cave resources (do OSHA standards apply to natural cave resources; bad air, radon, too small of openings). Ron Kerbo says that at the NSS meeting in the Fall this topic will be addressed and they are proposing that caves be exempted from OSHA confined space standards
- Unknown radon potential in caves; study should be done
- Mineral claims on north end of monument (gold and silver); consult GRD Mineral database

- Rock theft by visitors for home use and landscaping creating a disappearing resource

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UNIQUE GEOLOGIC FEATURES

The Craters of the Moon area has some spectacular geologic features; a few are listed below:

- Spatter cones
- Largest dominantly Holocene lava volcanic field in conterminous US
- Largest open rift in continent; well expressed rift zone
- Still potentially active volcanic field; i.e. non-extinct
- Cinder cones
- Close proximity of all the basaltic features in this small area (this is not very common) and the accessibility and compositional ranges of the flows
- Lava tubes and caves
- Rafted blocks incorporated into flows
- Open crack non-eruptive fissures (not within park boundaries but nearby)
- Blue Dragon flow from volcanic glass; blue comes from oxidation state of titanium
- kipukas

POTENTIAL RESEARCH TOPICS FOR CRATERS OF THE MOON NM

A list of potential research topics and future needs includes the following:

- study of the secondary minerals associated with the rift and lava tubes
- good cartographic survey of caves and their internal components
- North Crater study of the stratigraphy of cinder cones to work out volcanic processes involved in their formation
- Petrologic and chemical studies of the chemical similarity of flows and ashes to determine chemical fingerprinting
- Detailed study of Big Cinder Butte
- Study the mechanism of rift formation
- Study pahoehoe flows of the Blue Dragon flow; offers much insight into pahoehoe flows; work out ages of flow lobes
- Aa aa flows outside of park are basically unstudied; easily accessible outside park to understand processes and mechanisms of aa aa flows
- Use exposure dating techniques on lava flows (Beryllium, Helium etc.)
- Use Paleomagnetic methods for determining age relations of lava flows
- Study geothermal aspects of park without drilling; area has extremely high heat flow but we haven't been able to test or prove it to date; perhaps reinterpret aeromagnetic data for park
- Using drilling data, measure geothermal gradient at depth to determine how much heat flux is coming from deep crust and mantle for this part of the world. This can

reveal much about volcanic history of park and where magma batches and pools are formed and stored
- More seismic data for the area; gravity survey across rift
- More geochemical studies to Understand depth and location of magma chambers and nature of chemical variation (ex. Of time progression in silica content as it relates to evolving magma chamber (consult Mel's publications 1992 & 1986 for more information.)
- Analyze Precambrian xenoliths for crustal age and composition
- Quantify erosional impact around trails (John had a student using GIS spectral analysis)
- Feeder dike links; how extensive can eruptive fissures be; what is extent of magmatic system

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ACTION ITEMS

Many follow-up items were discussed during the course of the scoping session and are reiterated by category for quick reference.

Interpretation
- See about the availability of Michele Mycross to do the geologic report for CRMO

Paleontological and Speleological Resources
- Develop an in-house plan to inventory, monitor and protect significant resources from threats; assign staff to oversee

- Vince Santucci should be contacted about the CRMO paleo collection for his database

Geologic Mapping
- Maintain USGS-NPS cooperation to reap all possible products from existing work to benefit the NPS GRI

- Have Mel complete the missing pieces of the mapping; obtain permission from his superiors for his time

- Remove protected cave localities from existing maps unless they appear on the park map that is distributed to the public

Natural Resource Data Sources
- Attempt to obtain permission to reprint or web-post various publications on CRMO from various publishers

Miscellaneous
- Get Mel a copy of the CD-ROM containing the digitized CRMO maps

- Review proposed research topics for future studies within Craters of the Moon NM

- Provide the NPS "Cave Link" contact list to CRMO to establish better communications with other cave specialists in the NPS (Joel Despain, John Roth, etc.)

- Send Scott Hughes the ArcView graphics viewer software
- Locate any air quality data that may be useful for AQUIMS

- Fix NHS assignment for CIRO on priority list

- Contact Tim Funderburg from Idaho GS; Scott knows him , we should contact him

Tim D. Funderburg Idaho Geological Survey Box 8072 Pocatello, ID 83209
Phone: 208-236-3137 fundtim@isu.edu

- Get Mel's GSA abstract for our report; consult with GSA for permission

- Get with Dave Steensen on the Martin Mine logistics and remediate disturbed lands, trails, and roads within the monument

APPENDIX A
Craters of the Moon NM Geological Resources Inventory Workshop Participants
May 12-13, 1999

NAME	*AFFILIATION*	*PHONE*	*E-MAIL*	Field Trip	Scoping Session
Joe Gregson	NPS, Natural Resources Information Division	(970) 225-3559	Joe_Gregson@nps.gov	X	X
Tim Connors	NPS, Geologic Resources Division	(303) 969-2093	Tim_Connors@nps.gov	X	X
Ron Kerbo	NPS, Geologic Resources Division Cave Specialist	(303) 969-2097	Ron_Kerbo@nps.gov	X	
Marsha Davis	NPS, Columbia Cascades Support Office	(206) 220-4262	Marsha_Davis@nps.gov	X	X
Mel Kuntz	USGS, Denver	(303) 236-1293	Mkuntz@usgs.gov	X	X
Scott Hughes	Idaho State University	(208) 236-4387	Hughscot@isu.edu	X	X
John Apel	NPS, CRMO	(208) 527-3257	John_Apel@nps.gov	X	X
Bob DeTar	BLM, Idaho	(208) 373-3887	Bob_DeTar@blm.gov	X	
Terry Maley	BLM, Idaho	(208) 373-3820	Terry_Maley@blm.gov	X	
Doug Owen	NPS, CRMO	(208) 527-3257	Doug_Owen@nps.gov	X	X
Dave Clark	NPS, CRMO Interpretation	(208) 527-3257 ext. 301	Dave_Clark@nps.gov		X
Jim Morris	NPS, CRMO	(208) 527-3257 ext. 101	Jim_Morris@nps.gov	X	X

APPENDIX B
Overview of Geologic Resources Inventory

The NPS Geologic Inventory is a collaborative effort of the NPS Geologic Resources Division (GRD) and Inventory and Monitoring Program (I&M) with assistance from the U.S. Geological Survey (USGS), American Association of State Geologists (AASG), and numerous individual volunteers and cooperators at NPS units, colleges, and universities.

From the perspective of the servicewide I&M Program, the primary focus (Level 1) of the geological inventory is

1. to assemble a bibliography of associated geological resources for NPS units with significant natural resources,

2. to compile and evaluate a list of existing geologic maps for each unit,

3. to develop digital geologic map products, and

4. to complete a geological report that synthesizes much of the existing geologic knowledge about each park. The emphasis of the inventory is not to routinely initiate new geologic mapping projects, but to aggregate existing information and identify where serious geologic data needs and issues exist in the National Park System.

The NPS Geologic Resources Division is an active participant in the I&M Program and has provided guidance and funding in the development of inventory goals and activities. GRD administers the Abandoned Mine Lands (AML) and Geologists In Parks (GIP) programs which contribute to the inventory. NPS paleontologists, geologists, and other natural resource professionals also contribute to inventory planning and data. A major goal of the collaborative effort is to provide a broad baseline of geologic data and scientific support to assist park managers with earth resource issues that may arise.

For each NPS unit, a cooperative group of geologists and NPS personnel (the Park Team) will be assembled to advise and assist with the inventory. Park Teams will meet at the each NPS unit to discuss and scope the geologic resources and inventory, which is the subject of this report. If needed, a second meeting will be held at a central office to evaluate available geologic maps for digital production. After the two meetings, digital geologic map products and a geologic report will be produced. The report will summarize the geologic inventory activities and basic geology topics for each park unit. Due to the variety of geologic settings throughout the NPS, each report will vary in subject matter covered, and section topics will be adapted as needed to describe the geologic resources of each unit. Whenever possible the scientific sections of the report will be written by knowledgeable cooperators and peer reviewed for accuracy and validity.

APPENDIX D
Craters of the Moon NM
Index of Quadrangle Maps
(*1:48,000 scale*)